X-RAY COMPUTED MICROTOMOGRAPHY ON CONTRAST-ENHANCED SOIL SAMPLES AS A PROXY FOR SOIL ORGANIC MATTER AND MICROORGANISMS INTERACTIONS STUDY

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Soil pore structure plays a key role in microbial activity both directly by affecting microorganisms (MOs) and soil organic matter (SOM) distribution inside the soil matrix, and indirectly by regulating gas and liquid phases. Many studies already showed the importance of pore architecture for MOs activities (i.e. SOM decomposition), however there is still a lack of knowledge on their interactions mainly due to technical limitations on MOs and SOM detection inside the 3D soil structure. X-ray computed microtomography (μCT), which is based on X-ray linear attenuation coefficient (α), is extensively used as a valuable tool in 3D soil structure characterization. However a differentiation between SOM and soil mineral fractions has been hindered by an overlapping of their α, making segmentation of each soil fraction (e.g. SOM) difficult. Some Authors suggested to increase α of SOM by using osmium as a staining agent (SA) and successfully visualized stained-SOM inside soil samples by using synchrotron-based μCT, but the osmium toxicity and scarce accessibility of synchrotron beamlines make this method not routinely applicable. As a consequence, the aim of this study was to test two alternative (i.e., less toxic) SOM-staining agents to visualize, segment and quantify SOM inside the soil matrix through non-synchrotron μCT and evaluate their effect on MOs communities. A silty loam soil was air-dried, sieved at 2 mm and placed in a muffle furnace (550 °C, 4 h) for SOM removal. Maize silage (2 mm sieved) was shaken overnight with SAs solutions (phosphomolybdenic acid, and silver nitrate), centrifuged for 10 min at 1000 RPM and oven-dried at 60°C for 24 h. Stained silage was added into the dry soil in two concentrations (w/w) 1% and 5% and subjected to a first μCT scan with a 3.7-μm resolution. Successively, on repacked soil samples (1.3 g cm-3 bulk density), MOs were incubated into soil samples through water-based solution and subjected to a second μCT analysis with the same scanning parameters. Preliminary results showed that SAs increased α of SOM, simplifying its identification and the following segmentation, although some differences were observed according to staining agent type. SOM was discriminated from soil mineral fraction and estimated at comparable values to those initially weighted. By contrast, the visualization and following segmentation of stained-SOM was compromised after MOs incubation. Indeed the SA was washed out by water and likely dispersed in the soil matrix, involving in turn difficulties in image processing and further calculations. Moreover staining agents affected MOs communities suggesting a significant toxic effect. Even though this procedure showed a high potential for SOM-soil mineral fractions interaction studies as related to MOs activity, some concerns were highlighted after MOs incubation through water-based solutions suggesting weak staining agents-SOM bond and toxicity on MOs (Research funded by PROTINUS H2020 N°645717).

Parole chiave: X-ray computed microtomography, SOM-staining agents, soil organic matter and microorganisms interactions